Town of Guadalupe
Wastewater Collection System Assessment

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I. Executive Summary

The operation and maintenance of a Wastewater Collection System (WCS) is crucial to the health and safety of the general public. Therefore, the Town of Guadalupe (Town) contracted with Dibble Engineering (Dibble) to conduct a condition assessment of their WCS. The majority of the Town's WCS was constructed in 1978 and this condition assessment is the first to be completed on the system.

Condition assessment tasks consisted of creating a Geographic Information System (GIS) database; assigning identification for each WCS asset; identifying and inspecting each sanitary sewer access manhole; and cleaning and Closed-Circuit-Television (CCTV) of all sanitary sewer pipe. The Town's WCS includes 199 access manholes, 20 cleanouts, and 60,936 linear feet (11.5 miles) of pipe ranging in size from 8-inch to 18-inch.

At the start of the assessment, field visits were conducted to locate and mark each access manhole for the purpose of inspection and identifying the associated pipe segments to be cleaned and CCTV. Throughout this first step, previously unidentified manholes were discovered, and several other manholes could not be located due to being buried under sidewalk or asphalt roadway. Manholes found to be buried under soil were uncovered and assessed. Of the 199 access manholes, 7 could not be located. Manholes were inspected and assigned a grade or Good, Fair, or Poor. 14 manholes were observed to be in "Poor" condition and are recommended to be included in near term rehabilitation projects.

At the completion of the manhole locating process, pipe segment lists were generated to complete cleaning and CCTV of each pipe segment. Once CCTV was completed the resulting video was reviewed by National Association of Sanitary Sewer Companies (NASSCO) certified technicians to identify defects within each pipe segment. Observed defects are separated into two categories, Structural, and Operation & Maintenance (O&M). Each defect observed is assigned a number grade from 5 (severe) to 1 (excellent). 11 grade 5 structural defects and 31 O&M grade 5 defects were observed within the WCS. 2 pipe segments were observed to have multiple fractures resulting in partially collapsed pipe. These segments are recommended for immediate repair.

There are several methods of rehabilitation for access manholes which include corrosive resistant structural inserts or a corrosive resistant coating. The method selected is dependent on the severity of manhole deterioration. Early stages of deterioration, as was observed within the Town's WCS, will require a corrosive resistant epoxy coating.

There are also several methods of rehabilitation for sanitary sewer pipe which include point repair, patch point repair, and Cured-In-Place-Pipe (CIPP). Patch point repair and CIPP rehabilitation is a trenchless technology, meaning both can be installed through existing access manholes with minimal disruption to the traveling public as compared to open cut excavation replacement. Segments previously mentioned with grade 5 structural defects are recommended to be rehabilitated utilizing point repair or CIPP liner.

After careful evaluation and grading of all the manholes and pipe segments, 6 phases of rehabilitation were developed. Table 1 presents these 6 phases and provides estimated costs for each one. The Urgent Repair phase cannot wait for outside funding and must be completed as soon as possible. The other 5 phases can proceed each year, utilizing outside funding sources.

Table 1 – Rehabilitation Project Cost Summary

Description	Urgent Repair	Year One	Year Two	Year Three	Year Four	Year Five
Pipe Rehabilitation	$92k	$283k	$335k	$408k	$409	$325k
Manhole Rehabilitation	--	$142k	$95k	$22k	--	--
Engineer's Design	$20k	$55k	$56k	$56k	$53k	$43k
Construction Administration	$14k	$38k	$39k	$39k	$37k	$30k
Estimated Total =	**$126k**	**$518k**	**$525k**	**$525k**	**$499k**	**$398k**

The following report includes specific information pertaining to condition assessment findings, rehabilitation methods, recommendations, and probable construction costs.

II. Introduction

The operation and maintenance of a Wastewater Collection System (WCS) is crucial to the health and safety of the general public. The Town of Guadalupe (Town) contracted with Dibble Engineering (Dibble) to conduct a condition assessment of their WCS that includes sanitary sewer mainline pipe, access manholes, and cleanouts. The condition assessment followed National Association of Sanitary Sewer Companies (NASSCO) Pipeline Assessment Certification Program (PACP) coding and grading procedures. This report includes the condition assessment findings, along with recommendations for sanitary sewer pipe and access manhole rehabilitation for the Town's WCS over a 5-year period.

Work included identification of the Town's WCS assets and incorporating the features into a Geographic Information System (GIS) geodatabase. The Town's WCS consists of 199 access manholes, 20 cleanouts, and 60,936 linear feet of pipe (11.5 miles) ranging in size from 8-inch to 18-inch, refer to *Table 2* & *Table 3*. An aerial map shown on page 2 depicts the location of the assets identified.

Table 2 – WCS Pipe Assets

Pipe Diameter (in)	No. of Pipe Segments	Total Length (ft)
8	186	51,103
12	11	3,089
18	22	6,744
Total=		60,936

Table 3 – WCS Access Assets

Type	Access Diameter (in)	Quantity
Cleanout	6	20
Manhole	48	171
Manhole	60	28

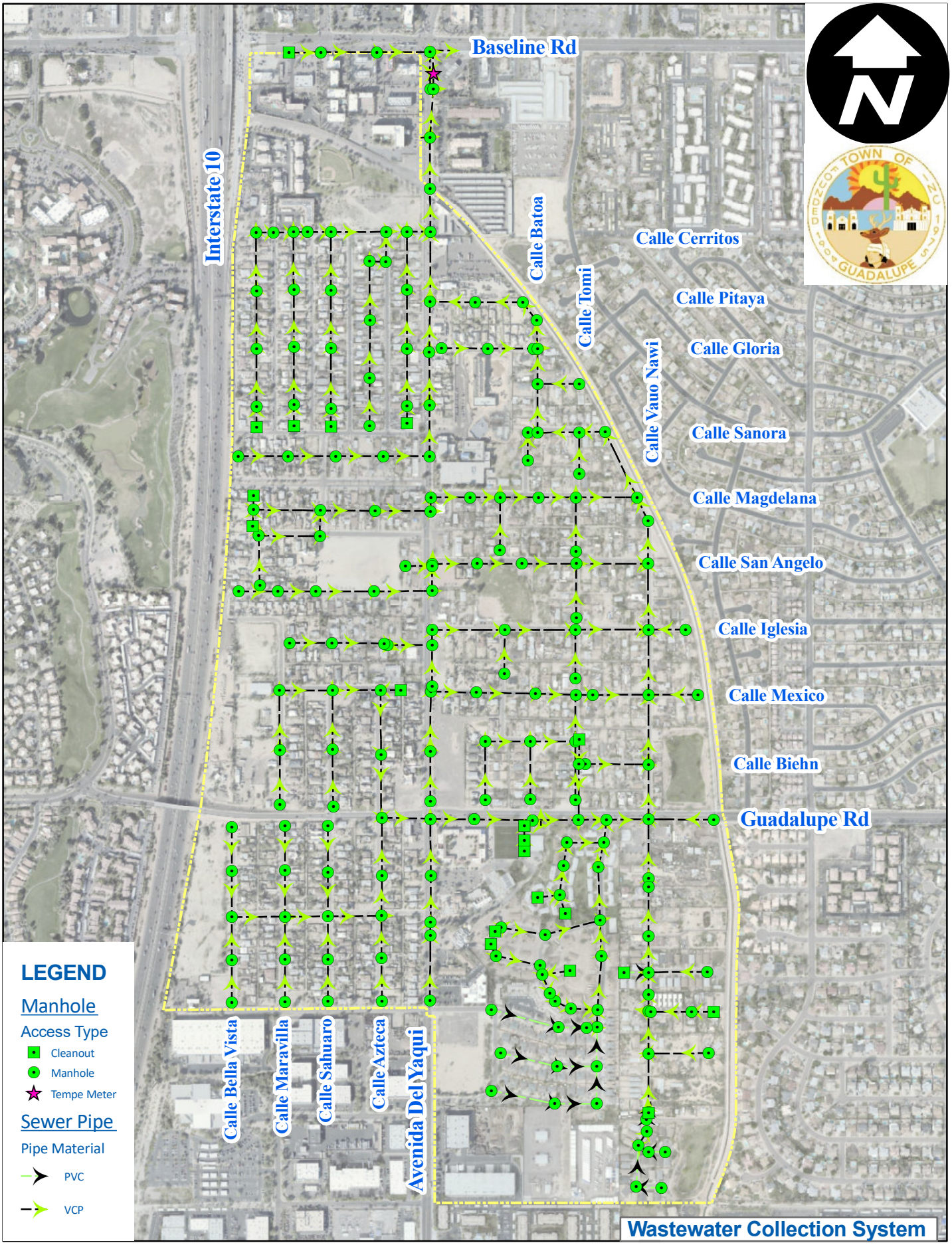
The Town's WCS discharges sanitary sewer flow at a single point into the City of Tempe's WCS. Flow quantities are measured at a meter located behind the sidewalk at 1435 W. Baseline Road.

As part of the GIS geodatabase creation, specific information was developed for each sanitary sewer pipe, access manhole, and cleanout and each were assigned a unique identification number.

Manhole identification numbers were obtained from existing Town As-built (AB) drawings completed by others, refer to *Table 4* as an example.

Table 4 - Manhole GIS Attribute Example

AssetID	MANHOLE_ID	UNIT_TYPE	DIAMETER	MATERIAL	OPENING	AB_DATE
CO007	COG-1	CLEANOUT	6	VCP	6	11/15/1978
MH091	B8-2	MANHOLE	48	Concrete	24	11/15/1978
MH189	JC-1	MANHOLE	60	Concrete	30	11/15/1978


Baseline Rd
Interstate 10
Calle Batoa
Calle Tomi
Calle Vauo Nawi
Calle Cerritos
Calle Pitaya
Calle Gloria
Calle Sanora
Calle Magdelana
Calle San Angelo
Calle Iglesia
Calle Mexico
Calle Biehn
Guadalupe Rd
Calle Bella Vista
Calle Maravilla
Calle Sahuaro
Calle Azteca
Avenida Del Yaqui
LEGEND
Manhole
Access Type
Cleanout
Manhole
Tempe Meter
Sewer Pipe
Pipe Material
PVC
VCP
Wastewater Collection System

Sanitary sewer pipe segments were assigned a unique identification number consisting of upstream and downstream manhole ID separated by an underscore, refer to *Table 5* as an example.

Table 5 - Sanitary Sewer Pipe GIS Attribute Example

AssetID	PIPE_ID	UPSTREAM_MH	DOWNSTREAM_MH	UNIT_TYPE	DIAMETER	PIPE_TYPE	AB_DATE
SS063	B-11_B-10	B-11	B-10	SS	8	VCP	11/15/1978
SS068	B-6_B-5	B-6	B-5	SS	12	VCP	11/15/1978
SS001	A-24_A-23	A-24	A-23	SS	18	VCP	11/15/1978

III. Manhole Condition Assessment

A. Condition Assessment

A properly functioning WCS includes structurally sound and accessible access manholes. As the first step of the assessment, field visits were conducted to physically locate all access manholes and mark the manhole ID number on each manhole. At this time, assessment of 192 of the Town's 199 sanitary sewer access manholes was conducted by visual inspection using 360-degree view video equipment lowered into the manhole. A condition grade of the manhole interior was assigned Good, Fair, or Poor, by onsite observation and viewing the video from the 360-degree view video equipment to document the interior.

The objective of the condition grade is to identify manholes at risk for failure and quickly prioritize the need for rehabilitation.

As mentioned, the total number of manholes assessed during this project is 192. 7 manholes could not be located due to being buried under concrete sidewalk or asphalt roadway. The locations of these inaccessible manholes were reported to the Town as requiring additional work to raise these manholes to grade, refer to *Figure 1.*

Figure 1 – Calle Batoua Buried Manhole

14 manholes were found to be in "Poor" condition. Typical defects observed were Surface Aggregate Projecting (SAP) and Surface Aggregate Visible (SAV). These defects indicate the manhole is in early stages of structural deterioration.

11 manholes were found to have cast iron covers with aluminum rings. This combination makes it difficult to open due to dissimilar metal corrosion as well as cast iron covers and aluminum rings differ in diameter.

Cast iron covers diameter is slightly larger than aluminum frames and when installed the covers are wedged into the ring. Replacement of these 11 aluminum rings with cast iron covers is recommended for providing future access.

IV. Pipeline Condition Assessment

A. Condition Assessment

As the first step of the assessment, field visits were conducted to physically locate all access manholes and mark the manhole ID number on each manhole. The second step of the assessment was to clean all the sanitary sewer pipe segments utilizing a hydro-blast jetter and vactor truck to remove dislodged debris. Cleaning operations consisted of up to 3 passes with the jetter. The third step was to CCTV video all the cleaned pipe segments, and then use the resulting videos for conducting viewing inspections and determining assessment designations.

Assessment of sanitary sewer pipe condition was conducted according to NASSCO PACP pipe condition grading system. The NASSCO PACP condition grading system assigns standardized codes for feature defects observed during CCTV video inspection. Defects observed within the interior of the pipe are assigned a score from 1 to 5, with 5 being severe condition. The various defect scores for each pipe segment are used to determine the overall condition of the pipe segment and the recommended time frame for rehabilitation, refer to *Table 6*.

Table 6 - NASSCO Pipe Condition Grades

General Grade	General Condition	Condition Definition	Recommendation
5	Severe	Most Significant Defect requiring immediate attention	Rehabilitate within 2 years
4	Poor	Significant Defects	Rehabilitate within 2-4 years
3	Fair	Moderate Defects	Re-inspect 5-7 years
2	Good	Minor to Moderate Defects	Re-inspect in 10 years
1	Excellent	Minor defect	Re-inspect in 10 years

Observed defects are categorized into three areas: structural, operation and maintenance (O&M), and construction features as follows:

1. Structural Defects

Structural category defects are those defects identifying physical damage to the strength of the pipe material. Structural defective pipe generally requires some level of construction repair to resolve. The type and quantity of structural defects observed within the Town's WCS is shown in *Table 7*.

Table 7 - Structural Defects Observed

Defect Code	Description	Grade	Quantity*
XP	Collapse Pipe	5	1
BSV	Broken Soil Visible	5	5
HSV	Hole Soil Visible	5	5
FM	Fracture Multiple	4	17
H	Hole	4	2
JOL	Joint Offset Large	4	2
JSL	Joint Separation Large	4	2
RPPD	Repair Point Patch Defective	4	1
B	Broken	3	2
CM	Crack Multiple	3	1
FL	Fracture Longitudinal	3	6
JOM	Joint Offset Medium	3	2
JSM	Joint Separation Medium	3	4
LFD	Liner Feature Detached	3	1
CL	Crack Longitudinal	2	12
FC	Fracture Circumferential	2	15
CC	Crack Circumferential	1	3
		Total =	**81**

*Number of observed occurrences

As noted above, grade 5 defects observed within the Town's WCS included Collapse Pipe (XP), Broken Soil Visible (BSV) and Hole Soil Visible (HSV), refer to *Figure 2*, *Figure 3*, and *Figure 4*.

Figure 2 - Collapse Pipe (XP) Defect

Figure 3 - Broken Soil Visible (BSV) Defect

Figure 4 - Hole Soil Visible (HSV) Defect

The condition assessment identified 10 pipe segments with grade 5 defects and 24 pipe segments with grade 4 defects.

2. Operation & Maintenance Defects

O&M category defects are interior pipe conditions that effect the operation of the pipe by restricting flow to various degrees and in some instances block the flow completely. O&M defect issues can be avoided through typical preventative maintenance procedures such as cleaning with a hydro jetter to remove the debris. The type and quantity of O&M defects observed is shown in *Table 8.*

Table 8 - O&M Defects Observed

Defect Code	Description	Grade	% of Pipe Blocked	Quantity
DNZ	Deposits ingress Settled	5	> 30	1
DSC	Deposits Settled Compact	5	> 30	5
DSZ	Deposits Settled Other	5	> 30	24
RBB	Root Ball Barrell	5	> 50	1
DSZ	Deposits Settled Other	4	20 ≤ 30	22
RBJ	Root Ball Joint	4	> 50	3
RBL	Root Ball Lateral	4	> 50	13
DSC	Deposits Settled Compact	3	10 ≤ 20	4
DSZ	Deposits Settled Other	3	10 ≤ 20	19
RML	Root Medium Lateral	3	15 ≤ 50	12
RMJ	Root Medium Joint	3	15 ≤ 50	17
DAE	Deposits Attachment Encrustation	2	≤ 10	19
DSGV	Deposits Settled Gravel	2	≤ 10	37
DSZ	Deposits Settled Other	2	≤ 10	19
RFB	Root Fine Barrell	1	≤ 15	1
RFC	Root Fine Connection	1	≤ 15	7
RFJ	Root Fine Joint	1	≤ 15	88
RFL	Root Fine Lateral	1	≤ 15	12
VC	Vermin Cockroach	1		1029

Figure 5 through *8* show typical grade 5 O&M defects observed within the Town's WCS.

Figure 5 - Deposits ingress Settled (DNZ) Defect

Figure 6 - Deposits Settled Compact (DSC) Defect

Figure 7 - Deposits Settled Other (DSZ) Defect

Figure 8 - Root Ball Barrell (RBB) Defect

These grade 5 defects typically require heavy cleaning by mechanical measures using a carbide saw or chain flail knocker and multiple passes with the hydro-blast jetter.

3. Construction Features

Construction features category of defects is used to identify various defects associated with the methods used to construct and connect pipes. Construction features include improperly installed service laterals (Taps), pipe joint construction, and pipe condition at access manholes. Construction feature defects have both structural and O&M grades assigned to them. The type and quantity of Construction Features defects observed is shown in *Table 9*.

Table 9 - Construction Features Defects Observed

Defect Code	Description	Grade	Category	% of Pipe Blocked	Quantity
TBD	Tap Break-in Defective	4	Structural		25
TFD	Tap Factory Defective	3	Structural		106
TBI	Tap Break-in Intruding	5	O&M	>30	10
TBI	Tap Break-in Intruding	4	O&M	20 ≤ 30	7
TBI	Tap Break-in Intruding	3	O&M	10 ≤ 20	10
TBI	Tap Break-in Intruding	2	O&M	≤ 10	5
TFI	Tap Factory Intruding	1	O&M		1
TB	Tap Break-In	1	Construction		31
TBA	Tap Break-In Active	1	Construction		40
TF	Tap Factory	1	Construction		506
TFA	Tap Factory Active	1	Construction		496
TFB	Tap Factory abandoned	1	Construction		6
TFC	Tap Factory Capped	1	Construction		12

There were several intruding service taps observed within the Town's WCS. The grade 5 TBI defect listed in the table above is protruding into the sewer main to block greater than 30-percent of the pipe cross sectional area which may cause backup due to debris being unable to pass the tap, refer to *Figure 9.*

Figure 9 - Tap Break-in Intruding (TBI) Defect

V. Manhole Rehabilitation

There are several important factors to consider when determining the type of rehabilitation method to use. The following sections discuss these factors.

A. Manhole Materials

The Town's WCS manholes are constructed of concrete materials. Access manhole materials identified in the assessment include only unreinforced concrete.

1. Concrete Manholes

Concrete manholes are extremely susceptible to corrosion in H2S gas environments. Over time H2S gas oxidizes and reacts with the silica cement. As the deleterious reaction continues, concrete spalls thus compromising structural integrity of the manhole. In high concentration H2S environments concrete deterioration can occur more quickly and thus rehabilitation may be required sooner without proper interior wall protection.

B. Methods of Manhole Rehabilitation

There are several methods for rehabilitating concrete sanitary sewer access manholes. Depending on the severity of deterioration these methods include installation of epoxy or polyurethane coatings, structural inserts, and complete replacement.

1. Epoxy or Polyurethane Coatings

One method of rehabilitation for concrete manholes is to prepare the interior of the manhole exposing sound, solid substrate and then installing a coating onto the interior surfaces of the manhole with either epoxy or polyurethane materials. Epoxy and polyurethane coatings consist of two components, a resin and a hardener, which are mixed just prior to application. Applications of epoxy coatings can be sprayed or troweled onto the concrete surface, refer to *Figure 10*. Polyurethane coatings typically use a spray application.

Figure 10 – Trowel Epoxy Coating Application

To avoid expensive bypass pumping costs, typically the coatings are applied during low flow conditions and the use of flow through plugs to eliminate water in the manhole invert. The coating is applied on all exposed surfaces.

Depending upon the environment within the manhole, surface preparation, quality of application, and physical damage to the coating after installation, the service life of coatings vary anywhere from 5 years in high H2S environments to upwards of 10 to 20 years.

Epoxy and polyurethane coatings are recommended solutions for concrete access manholes with early stages of concrete deterioration as observed within the Town's WCS. Indication of early stages are; increased surface roughness, concrete aggregate is visible, and surface spalling, refer to *Figure 11*.

Figure 11 - Early Concrete Deterioration

1. Structural Inserts

Rehabilitation for manholes with compromised structural performance can be accomplished using internal manhole structural inserts. The manhole structural insert is typically pre-fabricated, delivered to the site and inserted into the manhole interior. The structural inserts are typically constructed using fiberglass or polymer concrete, refer to *Figure 12* & *Figure 13*.

Figure 12 - Polymer Concrete Manhole Insert

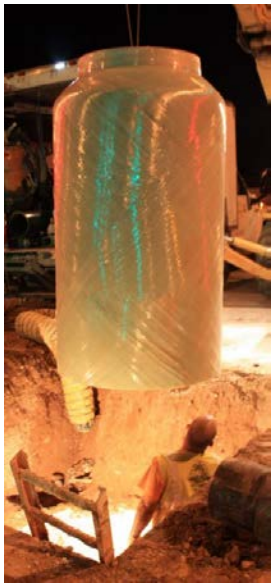


Figure 13 – JPCI Fiberglass Manhole Insert

The method of installation for pre-fabricated manhole inserts is described as follows: The cone of the existing manhole is removed, and the interior is then pressure-washed to removed loose material that may interfere with the insert installation. A leveling course of corrosive resistant grout is placed on the manhole bench to eliminate projections that could cause point loading on the insert. The leveling course of grout also seals the bottom of the insert to prevent annular space grout from leaking into the manhole channel during installation. Inserts can be fabricated as either one single unit, or in sections depending on the manufacturer or installation location constraints. Grout is then poured into the annular space between the new insert and existing manhole. The manhole is then backfilled, and frame and cover surface repairs are made to restore to original conditions.

To prevent water infiltration, a manufacturer approved sealant material is used at all joints and pipe connections. Since the pre-fabricated insert is designed to fit inside the existing manhole, the interior diameter of the new manhole will be reduced by approximately 6-inches.

VI. Pipe Rehabilitation

There are several important factors to consider when determining the type of rehabilitation method to use. The following sections discuss these factors.

A. Pipe Materials

The Town of Guadalupe WCS is constructed of two different materials, Vitrified Clay Pipe (VCP), and Polyvinyl Chloride (PVC) pipe.

1. Vitrified Clay Pipe

VCP is a corrosive resistant pipe, however, vitrified clay is brittle and is susceptible to fracturing from impacts during pipe and service lateral installations or soil settlement. Over time the fractures can propagate along the pipe possibly resulting in pipe collapse. From the assessment several pipe segments were observed to have fractures, cracks, and damaged break-in taps.

2. Polyvinyl Chloride Pipe

PVC is a corrosive resistant pipe and functions well if installed properly. No defects were observed within the PVC pipe segments.

B. Methods of Pipe Rehabilitation

There are several methods for rehabilitating both VCP and PVC sanitary sewer pipe. These methods include point repair, patch point repair, and Cured-In-Place-Pipe (CIPP) liner. The following sections discuss each of these methods.

1. Point Repair

Point repair is the open cut excavation method used to replace severely damaged or collapsed pipe, refer to *Figure 14.* Point repair is required where the pipe conditions are not conducive to CIPP lining. Point repair is the recommended method of rehabilitation and most cost effective where the defect is limited to approximately a 10-foot section, the pipe depth is less than 5-feet below the surface, and the location of the pipe is in a low traffic or landscaped area. To complete the point repair sewage must be diverted around the construction area.

Figure 14 - Point Repair

2. Patch Point Repair

Patch point repair is a trenchless rehabilitation method that is used to repair small defects in the host pipe. Patch point repair is performed through the installation of a three linear foot long section of CIPP liner containing an epoxy resin that hardens to form a pipe repair. CIPP patches can be overlapped to form a longer length of repair, however, the pipe diameter is decreased at the overlap location. Patch point repair is recommended when the pipe defect is limited to approximately one and a half linear feet. Typical defects requiring patch point repair would be small holes or sewer exfiltration through joints. Patch point repair is not recommended when cracks or fractures are present as there is a potential for cracks and fractures to propagate beyond the liner repair over time.

3. Cured-In-Place-Pipe

CIPP rehabilitation is a trenchless construction method that is used to repair existing sewer pipe 4-inches and larger, refer to *Figure 15 & Figure 16*. In the CIPP rehabilitation process, a resin-impregnated flexible felt, or fiberglass tube liner is inserted into the pipe through an existing access manhole using water, air pressure, or winched in using a cable. The resin is then cured inside the existing pipe using hot water, steam, or Ultraviolet (UV) light to form a tight-fitting, jointless, corrosion-resistant lining on the interior of the existing pipe. Service laterals are reinstated using remote controlled cutting devices. Lateral seal connections can be installed where the connection is damaged or is not water tight. The lateral seal connection prevents corrosion to the exposed pipe wall from the initial lateral reinstatement.

The thickness of CIPP lining is designed for fully-deteriorated host pipe conditions, various soil parameters, the presence of ground water, pipe ovality, and applicable live loads. Even though the pipe diameter is decreased, anticipated pipe flow capacity is typically increased due to a decreased coefficient of friction (smoother pipe wall) of the CIPP lined pipe.

A bypass pumping operation, cleaning, and removal of protruding objects, obstructions, and debris is usually necessary prior to CIPP rehabilitation. Bypass operations may not be required when pipe diameter is less than 12-inches depending on the storage capacity of the collection system upstream of the work area. Small diameter pipe flow can typically be handled with sewer system capacity at low flow conditions, for typically 2 to 4 hours while the liner is installed and cured.
Benefits of CIPP rehabilitation include:

- CIPP rehabilitation is a trenchless rehabilitation method and can be performed without excavation and disturbance of existing surface features. Existing service laterals are reinstated through trenchless technology.
- CIPP lining is tight-fitting, jointless, and corrosion-resistant, with minimal impact to pipe capacity.

When considering CIPP lining as a rehabilitation method, the following issues should also be considered:

- Changes in pipe alignment or drastic grade changes cannot be resolved without resultant liner wrinkling.
- Point repair is required prior to liner insertion to replace any collapsed pipe or to remove obstructions that cannot be removed by cleaning operations or man entry.
- Wrinkling of the CIPP lining may occur in pipe bends greater than 22.5 degrees.

Figure 15 – Inversion CIPP Liner Insertion

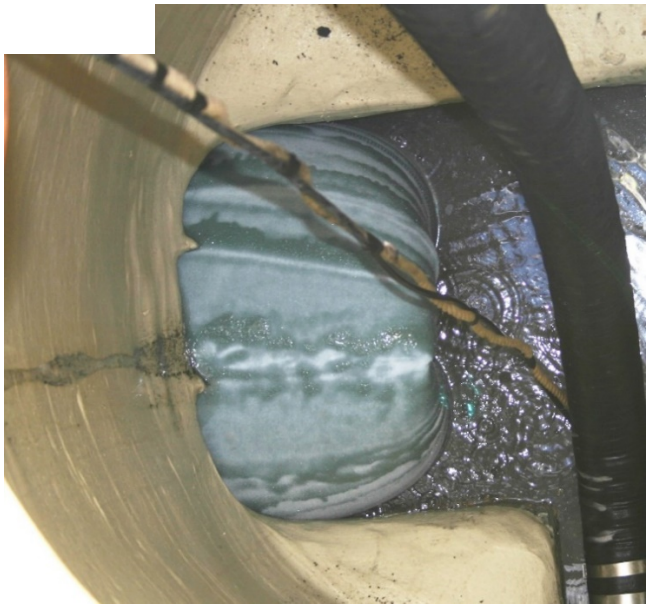


Figure 16 – Inflated CIPP Liner at Manhole Invert

VII. Recommendations

It is recommended that the Town implement a 5-year rehabilitation program to maintain the proper operation of the WCS. During the condition assessment, urgent structural and O&M defects needing repair before the 5-year implementation period were reported to the Town as they were identified. It is recommended that the Town immediately replace/rehabilitate those urgent repair segments/defects, refer to *Table 10* and the map on page 23.

Table 10 - Urgent Repair Projects

Pipe Segment	Pipe ID	Pipe Dia (in)	Pipe Length (ft)	Material	Structural Grade	O&M Grade	Defects Observed	Method	Est. Cost
1	G1-2_G1-1	8	402	VCP	5	1	Collapse	Point Repair	$80k
2	G1-3_G1-2	8	396	VCP	4	1	Fracture Multiple	Point Repair	
3	B6-2_B6-1	8	290	VCP	4	5	Root Ball Barrell	Heavy Cleaning	$12k
4	E-8_E-7	8	401	VCP	3	5	Root Ball Barrell	Heavy Cleaning	
5	F-8_F-7	8	376	VCP	4	5	Root Ball Barrell	Heavy Cleaning	
6	A1-3_A1-2	8	349	VCP	4	5	Root Ball Barrell	Heavy Cleaning	
7	G2-4_G2-3	8	398	VCP	3	5	Root Ball Barrell	Heavy Cleaning	
								Estimated Total =	**$92k**

A. Year One

Within the first year of the program it is recommended that the Town rehabilitate structural and O&M grade 5 pipe segments, raise seven access manhole covers to grade, and rehabilitate access manholes graded as fair and poor along the downstream end of the system. The recommended method of rehabilitation for pipe segments with structural and O&M grade 5 defects is CIPP liner and point repair, refer to *Table 11*.

Table 11 – Year One Pipe Rehabilitation Projects

Pipe ID	Pipe Dia (in)	Pipe Length (ft)	Material	Structural Grade	O&M Grade	Defects Observed	Method	Est. Cost
B-5_B-4	12	359	VCP	5	5	Broken Soil Visible	Point Repair	$65k
D-4A_D-4	8	308	VCP	5	5	Broken Soil Visible	CIPP Liner	$40k
G4-2_G4-1	8	394	VCP	5	4	Hole Soil Visible	CIPP Liner	$45k
A1-1_A-7	8	344	VCP	5	2	Broken Soil Visible	CIPP Liner	$42k
H-5_H-4	8	406	VCP	5	2	Broken Soil Visible	CIPP Liner	$47k
H-6_H-5	8	374	VCP	5	2	Broken Soil Visible	CIPP Liner	$44k
							Estimated Construction Cost =	**$283k**

All construction costs developed in this assessment are based on previously completed rehabilitation projects of similar scope and may vary from the actual costs at time of construction. Estimated construction items include Mobilization/Demobilization, by-pass pumping operations, pre and post construction CCTV, CIPP liner installation, remove and replace sanitary sewer pipe, and traffic control.

The recommended method of rehabilitation for access manholes is epoxy coating, and polymer grout coating on bench due to the manholes being in early stages of deterioration. Manhole deterioration has not progressed to the extent where a structural insert is necessary, refer to *Table 12*. It is also recommended that the 7 manholes buried under sidewalk and asphalt should be raised to grade.

Table 12 – Year One Manhole Rehabilitation Project Cost

Manhole ID	Diameter (in)	Depth (ft)	Grade	Method	Est. Cost
A-7	60	24.3	Poor	Coating	$21k
A-6	60	21.3	Poor	Coating	$21k
A-5	60	18.8	Poor	Coating	$21k
A-4	60	19.2	Poor	Coating	$21k
A-3	60	12.9	Fair	Coating	$13k
A11-1	48	12.5	Poor	Coating	$10k
A11-2	48	12	Poor	Coating	$11k
A10-3A2	Unknown	Unknown	Unknown	Raise	$3k
B7-2	Unknown	Unknown	Unknown	Raise	$3k
B6-1	Unknown	Unknown	Unknown	Raise	$4k
D3-1	Unknown	Unknown	Unknown	Raise	$3k
A-14	Unknown	Unknown	Unknown	Raise	$4k
A3-1	Unknown	Unknown	Unknown	Raise	$4k
F-4A	Unknown	Unknown	Unknown	Raise	$3K
				Estimated Construction Cost =	**$142k**

Construction items include Mobilization/Demobilization, cleaning manhole interior, coating application and traffic control.

B. Year Two

Within the second year of the program it is recommended that the Town rehabilitate structural and O&M grade 5 pipe segments and access manholes graded as poor. The recommended method of rehabilitation for these pipe segments is CIPP liner and point repair, refer to *Table 13*.

Table 13 – Year Two Pipe Rehabilitation Projects

Pipe ID	Pipe Dia (in)	Pipe Length (ft)	Material	Structural Grade	O&M Grade	Defects Observed	Method	Est. Cost
A5-1_A-15	8	289	VCP	5	2	Hole Soil Visible	CIPP Liner	$40k
A10-4A_A10-4	8	398	VCP	5	1	Hole Soil Visible	CIPP Liner	$46k
A1-2_A1-1	8	365	VCP	5	1	Hole Soil Visible	CIPP Liner	$44k
A10-2_A10-1A	8	333	VCP	4	5	Tap Break-in Intruding	Point Repair	$20k
D-3_D-2	8	496	VCP	4	5	Tap Break-in Intruding	Point Repair	$20k
J-8_J-7	8	255	PVC	4	5	Tap Factory Defective	CIPP Liner	$36k
A11-3_A11-2	8	366	VCP	5	2	Hole Soil Visible	Point Repair, CIPP Liner	$75k
F-1_A-17	8	418	VCP	4	4	Joint Offset Medium	CIPP Liner	$22k
A6-1_A-20	8	256	VCP	4	4	Crack Longitudinal	CIPP Liner	$32k
							Estimated Construction Cost =	**$335k**

The recommended method of rehabilitation for access manholes is epoxy coating, and polymer grout coating on bench due to the manholes being in early stages of deterioration. Manhole deterioration has not progressed to the extent where a structural insert is necessary, refer to *Table 14*.

Table 14 – Year Two Manhole Rehabilitation Project Cost

Manhole ID	Diameter (in)	Depth (ft)	Grade	Method	Est. Cost
A-24	60	16.9	Poor	Coating	$16k
B-11	48	11.1	Poor	Coating	$9k
B-2A	60	15.6	Poor	Coating	$15k
E-3	48	7.9	Poor	Coating	$7k
E-4	48	8.1	Poor	Coating	$7k
F-4	48	7.7	Poor	Coating	$7k
B-10	48	10.8	Poor	Coating	$9k
B1-1	60	14.3	Poor	Coating	$14k
J-5	60	10.6	Poor	Coating	$11k
				Estimated Construction Sub-Total =	**$95k**

C. Year Three

Within the third year of the program it is recommended that the Town rehabilitation structural grade 4 pipe segments and replace mis-matched frame and covers (F&C) on manholes. The recommended method of rehabilitation for pipe segments with structural and O&M grade 5 defects is CIPP liner and point repair, refer to Table 15.

Table 15 – Year Three Pipe Rehabilitation Projects

Pipe ID	Pipe Dia (in)	Pipe Length (ft)	Material	Structural Grade	O&M Grade	Defects Observed	Method	Est. Cost
A-12_A-11	18	194	VCP	4	4	Tap Break-in Defective	CIPP Liner	$34k
B-2A1_B-2A	8	383	VCP	4	4	Tap Break-in Defective	CIPP Liner	$48k
A3-1_A-13	8	286	VCP	4	3	Fracture Multiple	CIPP Liner	$36k
F-3_F-1	8	259	VCP	4	3	Fracture Circumferential	CIPP Liner	$32k
D1-1_D-1	8	333	VCP	4	3	Crack Longitudinal	CIPP Liner	$42k
H-1_B-6	8	435	VCP	4	3	Fracture Multiple	CIPP Liner	$54k
A-19_A-18	18	294	VCP	4	3	Tap Break-in Defective	CIPP Liner	$51k
G-7_G-6	8	397	VCP	4	2	Crack Longitudinal	CIPP Liner	$50k
D-2_D-1	8	487	VCP	4	2	Joint Separated Large	CIPP Liner	$61k
							Estimated Construction Cost =	**$408k**

Table 16 – Year Three Manhole Rehabilitation Projects

Manhole ID	Diameter (in)	Opening (in)	MH Grade	Method	Est. Cost
A1-4	48	24	Fair	Replace F&C	$2k
A1-5	48	24	Fair	Replace F&C	$2k
A7-1	48	24	Good	Replace F&C	$2k
E1-1	48	24	Good	Replace F&C	$2k
F2-1	60	24	Good	Replace F&C	$2k
G1-1	48	24	Good	Replace F&C	$2k
G2-4	48	24	Fair	Replace F&C	$2k
G3-3	48	24	Fair	Replace F&C	$2k
G4-1	48	24	Fair	Replace F&C	$2k
G4-2	48	24	Fair	Replace F&C	$2k
G-4A	48	24	Fair	Replace F&C	$2k
				Estimated Construction Sub-Total =	**$22k**

D. Year Four

Within the fourth year of the rehabilitation program is it recommended to rehabilitate structural grade 4 pipe segments, no manhole repairs or replacement are required for this year. The recommended method of rehabilitation for these pipe segments is CIPP liner and point repair, refer to *Table 17*.

Table 17 – Year Four Pipe Rehabilitation Projects

Pipe ID	Pipe Dia (in)	Pipe Length (ft)	Material	Structural Grade	O&M Grade	Defects Observed	Method	Est. Cost
A1-5_A1-4	8	324	VCP	4	2	Fracture Multiple	CIPP Liner	$41k
J-4_J-3	8	248	VCP	4	2	Fracture Multiple	CIPP Liner	$31k
JC-1_J-5	8	184	VCP	4	2	Fracture Multiple	CIPP Liner	$23k
J-3_J-2	8	365	VCP	4	2	Hole (no soil visible)	CIPP Liner	$46k
JA-3_JA-2	8	201	VCP	4	2	Fracture Multiple	CIPP Liner	$25k
F1-1_F-1	8	369	VCP	4	1	Fracture Multiple	CIPP Liner	$46k
G4-3_G4-2	8	397	VCP	4	1	Fracture Multiple	CIPP Liner	$50k
F-4A_F-4	8	207	VCP	4	1	Joint Offset Large	Point Repair	$22k
JC-6_JC-5	8	311	VCP	4	1	Joint Offset Large	Point Repair	$39k
D-6_D-5	8	361	VCP	4	1	Fracture Multiple	CIPP Liner	$45k
A1-6_A1-5	8	329	VCP	4	1	Fracture Multiple	CIPP Liner	$41k
							Estimated Construction Cost =	**$409k**

E. Year Five

Within the fifth year of the rehabilitation program it is recommended to rehabilitate the remaining structural grade 4 and O&M grade 5 pipe segments, no manhole repairs or replacement are required for this year. The recommended method of rehabilitation for these pipe segments is CIPP liner and point repair, refer to *Table 18*.

Table 18 – Year Five Pipe Rehabilitation Projects

Pipe ID	Pipe Dia (in)	Pipe Length (ft)	Material	Structural Grade	O&M Grade	Defects Observed	Method	Est. Cost
A1-4_A1-3	8	318	VCP	4	1	Fracture Multiple	CIPP Liner	$40k
A7-1_A-22	8	340	VCP	4	1	Tap Break-in Defective	CIPP Liner	$43k
H2-2_H2-1	8	394	VCP	4	1	Hole (no soil visible)	CIPP Liner	$59k
A8-1_A-23	8	433	VCP	4	1	Tap Break-in Defective	CIPP Liner	$54k
B1-2_B1-1A	12	91	VCP	4	1	Tap Break-in Defective	CIPP Liner	$18k
F-4_F-3	8	262	VCP	4	1	Tap Break-in Defective	CIPP Liner	$33k
E-1_A-19	8	494	VCP	3	5	Tap Break-in Intruding	Point Repair	$14k
A11-4_A11-3	8	384	VCP	3	5	Tap Break-in Intruding	Point Repair	$19k
CO-2A1_B-2A1	8	169	VCP	3	5	Tap Break-in Intruding	Point Repair	$13k
D2-1_D-2	8	301	VCP	3	5	Tap Break-in Intruding	Point Repair	$18k
COG1-1_G1-3	8	116	VCP	3	5	Tap Break-in Defective	CIPP Liner	$14k
							Estimated Construction Cost =	**$325k**

F. Summary

The following is a summary of rehabilitation project costs by year, refer to *Table 19*. A 5-year rehabilitation phasing map can be found on page 23.

Table 19 – Rehabilitation Project Cost Summary

Description	Urgent Repair	Year One	Year Two	Year Three	Year Four	Year Five
Pipe Rehabilitation	$92k	$283k	$335k	$408k	$409	$325k
Manhole Rehabilitation	--	$142k	$95k	$22k	--	--
Engineer's Design	$20k	$55k	$56k	$56k	$53k	$43k
Construction Administration	$14k	$38k	$39k	$39k	$37k	$30k
Estimated Total =	**$126k**	**$518k**	**$525k**	**$525k**	**$499k**	**$398k**

G. Cleaning & Next Assessment

As part of maintaining a properly functioning WCS, it is recommended that the sanitary sewer pipes be cleaned using hydro-jetting. Since this is the first condition assessment of the system and overall the system is functioning properly, it is recommended that cleaning be conducted in combination with the next condition assessment. It is recommended the Town conduct a new assessment of the WCS within 5 years after the conclusion of the 5-year rehabilitation program. Anticipated costs for the future assessment are reflected in *Table 20*.

Table 20 - Anticipated Future Assessment Costs

Description	Cost
Assessment Services	$38k
CCTV Inspection Services	$98k
Estimated Total =	**$136k**

H. Other Notable Findings

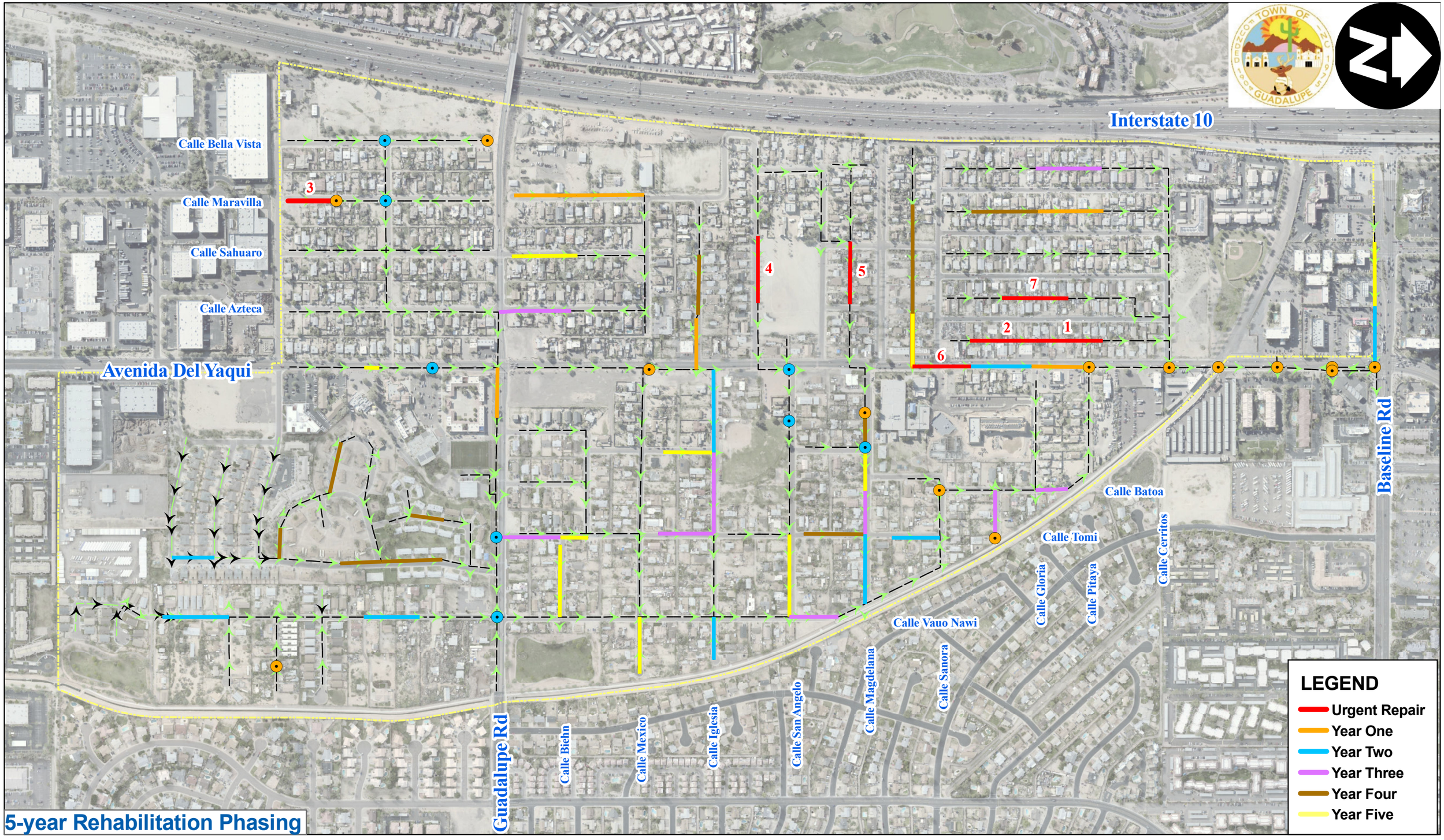
1. Service Lateral Root Intrusion

The condition assessment process identified 24 O&M root intrusion defects extending from service laterals into the mainline pipe, refer to *Figure 17*. Roots observed entering the mainline from service laterals could create issues for the owners of the home or business the lateral is servicing. It is recommended that the owners with roots observed in their laterals be notified in order to give them the opportunity of having them removed prior to the root creating a back-up problem. Town ordinances clarify that the service lateral extending from the home/business to the main line is the responsibility of the owner.

Figure 17 - Lateral Root Intrusion

2. Cockroach Infestation

The condition assessment of manholes and pipe segments revealed a considerable quantity of cockroaches. Cockroaches living in a WCS are capable carrying disease picked up within the system and transmitting the disease to the public. Surrounding municipalities have instituted manhole insecticide programs to mitigate the growth of cockroaches within the system thus minimizing the potential spreading of diseases. As an example, the city of Phoenix is currently on a 2-year treatment cycle. For each cycle the paint color is changed to identify the year the application was completed. It is recommended that the Town implement a similar 2-year treatment cycle. The anticipated cost for each 2-year treatment is $3,500.



5-year Rehabilitation Phasing